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ELECTRO-OPTICAL DEVICE AND ELECTRONIC DEVICE

[Claims]

[Claim 1] An electro-optical device, characterized by comprising:

a substrate formed with a plurality of signal electrode means;

a substrate formed with a plurality of scanning electrode means facing the substrate formed with the plurality of signal electrode means, the plurality of signal electrode means and the plurality of scanning electrode means being arranged in a matrix when viewed in a plane to define image display regions, the substrate being formed with a drive circuit means provided thereon for driving the signal electrode means and the scanning electrode means, the drive circuit means being connected to individual signal electrode means or individual scanning electrode means through a plurality of routing wirings formed on each of the substrates;

the routing wirings to connect the drive circuit means to the electrode means being formed on one of the substrates that corresponds to a picture-frame area located at the end side of the electrodes extending in one of the directions along which the plurality of electrodes are arranged in a matrix shape, routing sub-wirings being formed in a picture-frame area on

the other substrate not formed with the routing wirings so as to face the routing wirings, and the routing wirings and the routing sub-wirings facing each other on both the substrates being conducted by vertical conduction members laid between the substrates.

[Claim 2] The electro-optical device according to claim 1, characterized by electrode means of a column side being formed on the one of the substrates, electrode means of a row side being formed on the other of the substrates, the routing sub-wirings being formed in picture-frame areas formed on left and right sides of the one of the substrates, routing wirings for the electrode means of a row side being formed in picture-frame areas on left and right sides of the other of the substrates, the routing sub-wirings on the one of the substrates being connected to the routing wirings on the other of the substrates facing the routing sub-wirings by the vertical conduction members, the electrode means of a column side on the one of the substrates being connected to a drive circuit means through connecting wirings of a column side formed on the one of the substrates, and the routing sub-wirings on the one of the substrates being connected to a drive circuit means through connecting wirings of a row side formed on the one of the substrates.

[Claim 3] The electro-optical device according to claim 1, characterized by electrode means of a row side being formed

on the one of the substrates, electrode means of a column side being formed on the other of the substrates, routing wirings connected to the electrode means of a row side being formed in picture-frame areas formed on left and right sides of the one of the substrates, routing sub-wirings for the electrode means of a row side being formed in picture-frame areas formed on left and right sides of the other of the substrates, the routing wirings on the one of the substrates being connected to the routing sub-wirings on the other of the substrates facing the routing wirings by the vertical conduction members, the electrode means of a column side on the other of the substrates being connected to a drive circuit means through connecting wirings of a column side formed on the one of the substrates, and the routing wirings on the one of the substrates being connected to a drive circuit means through connecting wirings of a row side formed on the one of the substrates.

[Claim 4] The electro-optical device according to any one of the claims 1 to 3, characterized by picture-frame areas having an equal width being formed on left and right sides of the image display regions.

[Claim 5] The electro-optical device according to any one of the claims 1 to 4, characterized by the routing sub-wirings being formed to be independent wirings which are not connected to any one of the electrode means on the substrate formed with the routing sub-wirings.

[Claim 6] The electro-optical device according to any one of the claims 1 to 5, characterized by the vertical conduction members including a plurality of conductive particles dispersed inside an insulating resin layer.

[Claim 7] The electro-optical device according to any one of the claims 1 to 6, characterized by liquid crystals being sealed between a pair of substrates by a seal layer laid in a peripheral part of the pair of substrates, a part of an area disposed with the seal layer being formed to be a picture-frame area disposed with the routing wirings and the routing sub-wirings, a plurality of conductive particles being dispersed inside the seal layer, and the conductive particles bringing the routing wirings and the routing sub-wirings into vertical conduction.

[Claim 8] The electro-optical device according to claim 7, characterized by a gap agent to control a thickness of a liquid crystal layer being dispersed in the seal layer.

[Claim 9] The electro-optical device according to any one of the claims 1 to 8, characterized by the plurality of routing wirings formed on the picture-frame areas including a routing wiring for an electrode means located farther from the drive circuit means that has a width greater than another routing wiring for another electrode means located closer to the drive circuit means, with the electrode means being connected to the drive circuit means.

[Claim 10] The electro-optical device according to any one of the claims 1 to 9, characterized in that the signal electrode means include a pixel electrode part formed at every pixel and a two-terminal nonlinear element disposed between the signal wiring part and the pixel electrode part.

[Claim 11] An electronic device characterized by comprising an electro-optical device according to any of the claims 1 to 10 as a display means.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to an electro-optical device and an electronic device and particularly, to a technique for employing a special wiring structure for a portion of a periphery of an image display region that is referred to as a picture-frame area.

[0002]

[Related Art]

A liquid crystal display is widely used as a means for displaying a variety of information for mobile electronic devices, such as a notebook personal computer, a mobile electronic device and a wristwatch, for example. FIG. 10 shows a schematic view of an example of a passive matrix liquid crystal display widely used in this type of liquid crystal displays. A liquid crystal display 100 in this example has a pair of transparent substrates 101, 102 arranged facing each other with a suitable cell gap and a liquid crystal 105 sealed between the substrates 101, 102 by a sealing material 103 arranged in a peripheral part of the substrates facing each other. A plurality of strip-shaped electrodes (segment electrodes) 106 formed of transparent conductive materials are formed to individually extend in the longitudinal direction, as in FIG. 10, to the liquid-crystal-side internal surface of

the substrate 101. A plurality of strip-shaped electrodes (common electrodes) 107 formed of transparent conductive materials are formed to extend in a direction orthogonal to (in a lateral direction in FIG. 10a) the electrode 106 to the liquid-crystal-side internal surface of the substrate 102. A plurality of electrodes 106 and a plurality of electrodes 107 arranged in a matrix shape when viewed in a plane.

[0003]

A drive circuit element 109 is connected to one end of the substrate 101 through routing wiring 108 extending from each of the plurality of electrodes 106. A drive circuit element 111 is connected to the left-side end of the substrate 102 through routing wiring 110 extending from each of the plurality of electrodes 107. Two drive elements 109, 111 individually controls alignment conditions of liquid crystal molecules arranged between the crossed portions of the plurality of electrodes 106, 107 arranged in a matrix, thereby controlling the condition of light passing through a liquid crystal layer to allow image display. The region where the electrodes are arranged in a matrix is therefore the image display region.

The liquid crystal display 100 shown in FIG. 10 is provided with an retardation film and a polarizing plate in addition to the components described above. A backlight is disposed when the liquid crystal display 100 is a transmissive

type, a color filter is disposed when it is a color display type and a reflective layer is disposed when it is a reflective type. However, the description of these components is omitted for simplicity in FIG. 10.

[0004]

An drive circuit element 111 is provided on the side end of the substrate 102 for the liquid crystal display 100 shown in FIG. 10. There is therefore a drawback that a space for mounting the drive element 111 is required next to an actual image display region. In addition, the construction shown in FIG. 10 has a problem that an image display region cannot be arranged in the central part of the liquid crystal display 100. If an image display region cannot be provided in the central part of the liquid crystal display 100 as described above, the left and right portions of the image display region are different in width particularly for small-sized information processing units such as mobile telephones. This leads to a problem of being subjected to a large restriction due to screen arrangement relations.

[0005]

Under the above-mentioned background, the inventors propose a liquid crystal display whose schematic construction is shown in FIG. 11 as a result of their research and development.

For the liquid crystal display 120 shown in FIG. 11, a

pair of substrates 121, 123 holding the liquid crystal therebetween have the same lateral width when arranged to face each other. The substrate 123 is formed to have a smaller longitudinal width than the substrate 121. Of those electrodes that are arranged in a matrix, a plurality of electrodes (signal electrodes) 122 are formed column-wise on one substrate 121 and a plurality of electrodes (scanning electrodes) 125 are formed row-wise on the other substrate 123. Frame areas 126, 127 having an approximately equal width are provided on both sides of a region where these electrodes are arranged in a matrix when viewed in a plane. Routing wirings 128 alternately extend to the side portion of the substrate 121 corresponding to both of the picture-frame areas 126, 127 from the ends of the plurality of electrodes 125 formed row-wise. These routing wirings are connected to a drive element 130 provided at the end of one substrate 121.

Routing wirings 131 extending from the plurality of electrodes 122 formed column-wise on the other substrate 123 are connected from the substrate 123 to the substrate 121 through vertical conduction members (not shown) arranged at the border between both of the substrates 121, 123. The routing wirings 131 are then connected to the drive element 130. A flexible substrate connected to the drive element 130 is indicated by reference numeral 132 in FIG. 11.

[0006]

[Problems to be Solved by The Invention]

In the liquid crystal display 120 shown in FIG. 11, the picture-frame areas having an equal width are formed on both of the substrates. The liquid crystal display therefore has an excellent feature: the image display region is arranged in the central portion of the display and there is one drive element, as compared with two drive elements required in the conventional construction shown in FIG. 10. To simplify the description, the picture-frame areas 126, 127 are shown to be wide on both the right- and left-sides of the image display region, in FIG. 11. However, it is possible to form routing wirings narrow. In an actual device, the picture-frame area 126, 127 can therefore be formed to be much narrower than shown in FIG. 11, for example, a few millimeters wide or so and it is possible to attempt to form a narrower picture-frame area in the construction shown in FIG. 11.

However, in the liquid crystal display 120 shown in FIG. 11, there is a different distance between the each of the plurality of electrodes formed in row-wise and the drive element 130. The display therefore has a problem that the routing wiring 128 connected to the electrode 125 located closer to the drive element 130 will be greatly different in length from the routing wiring 128 connected to the electrode 125 located farther from to the drive element 130. If these routing wiring 128 are very different in length, there will

be a different wiring resistance for each electrode. If, in particular, the liquid crystal display is of the passive matrix type, there will be a subtle difference between the electric field provided to the liquid crystal by the electrode 125 located farther from the drive element 130 and the electric field provided to the liquid crystal by the electrode 125 located closer to the drive element 130. There is a problem that uniform brightness may not be attainable for each electrode even if each electrode is controlled to apply a uniform electric field. If, in addition, a drive voltage is applied to an electrode having the wirings with a large resistance, the actual value for the voltage applied to the liquid crystal may change because drive voltage waveforms tend to be easily degraded.

[0007]

The present invention considers the above-mentioned problems. An object of the present invention is to provide an electro-optical device that can lower resistance for routing wirings provided in a picture-frame area around an image display region and that can perform display with uniform brightness making degraded drive waveforms in an electrode means located closer to a drive circuit means and an electrode means located farther from a drive circuit means uniform whenever possible.

Another object of the present invention is to provide

an electro-optical device that can attain the same effects described above and enable a narrower picture-frame area even if a picture-frame area with an equal width is provided on both the left and right side of a periphery of a image display region.

Another object of the present invention is to provide an electronic device provided with an excellent electro-optical device mentioned above.

[0008]

[Means for Solving the Problems]

In order to address the problem described above, an electro-optical device in accordance with the present invention is characterized by comprising a substrate formed with a plurality of signal electrode means, a substrate formed with a plurality of scanning electrode means facing the substrate formed with the plurality of signal electrode means, the plurality of signal electrode means and the plurality of scanning electrode means being arranged in a matrix when viewed in a plane to define image display regions, the substrate being formed with a drive circuit means provided thereon for driving the signal electrode means and the scanning electrode means, the drive circuit means being connected to individual signal electrode means or individual scanning electrode means through a plurality of routing wirings formed on each of the substrates, the routing wirings to connect the drive circuit means to the electrode means being formed on one of the substrates that

corresponds to a picture-frame area located at the end side of the electrodes extending in one of the directions along which the plurality of electrodes are arranged in a matrix shape, routing sub-wirings being formed in a picture-frame area on the other substrate not formed with the routing wirings so as to face the routing wirings, and the routing wirings and the routing sub-wirings facing each other on both the substrates being conducted by vertical conduction members laid between the substrates.

[0009]

The routing wirings and the routing sub-wirings are formed to face each other on the substrates facing each other and are connected by the vertical conduction members. Thus, wiring resistance can be lowered than in the case of the wiring only with the routing wirings. Accordingly, display can be performed hardly causing degraded signal waveforms without generating uneven brightness, even though the drive circuit means applies signals to the scanning electrode means or signal electrode means at any position in the image display regions.

[0010]

An electro-optical device in accordance with the present invention is characterized by electrode means of a column side being formed on the one of the substrates, electrode means of a row side being formed on the other of the substrates, the routing sub-wirings being formed in picture-frame areas formed

on left and right sides of the one of the substrates, routing wirings for the electrode means of a row side being formed in picture-frame areas on left and right sides of the other of the substrates, the routing sub-wirings on the one of the substrates being connected to the routing wirings on the other of the substrates facing the routing sub-wirings by the vertical conduction members, the electrode means of a column side on the one of the substrates being connected to a drive circuit means through connecting wirings of a column side formed on the one of the substrates, and the routing sub-wirings on the one of the substrates being connected to a drive circuit means through connecting wirings of a row side formed on the one of the substrates.

The routing wirings and the routing sub-wirings connected to the electrode means are formed to face each other on the substrates facing each other and are connected by the vertical conduction members. Thus, wiring resistance can be lowered than in the case of the wiring only with the routing wirings. Accordingly, display can be performed hardly causing degraded signal waveforms without generating uneven brightness, even though the drive circuit means applies signals to the electrode means at any position in the image display regions.

[0011]

An electro-optical device in accordance with the present

invention is characterized by electrode means of a row side being formed on the one of the substrates, electrode means of a column side being formed on the other of the substrates, routing wirings connected to the electrode means of a row side being formed in picture-frame areas formed on left and right sides of the one of the substrates, routing sub-wirings for the electrode means of a row side being formed in picture-frame areas formed on left and right sides of the other of the substrates, the routing wirings on the one of the substrates being connected to the routing sub-wirings on the other of the substrates facing the routing wirings by the vertical conduction members, the electrode means of a column side on the other of the substrates being connected to a drive circuit means through connecting wirings of a column side formed on the one of the substrates, and the routing wirings on the one of the substrates being connected to a drive circuit means through connecting wirings of a row side formed on the one of the substrates.

The routing wirings and the routing sub-wirings connected to the electrode means are formed to face each other on the substrates facing each other and are connected by the vertical conduction members. Thus, wiring resistance can be lowered than in the case of the wiring only with the routing wirings. Accordingly, display can be performed hardly causing degraded signal waveforms without generating uneven

brightness, even though the drive circuit means applies signals to the electrode means at any position in the image display regions.

[0012]

An electro-optical device in accordance with the present invention is characterized by picture-frame areas having an equal width being formed on left and right sides of the image display regions.

The picture-frame areas with an equal width are formed at the left and right sides of the image display regions. Therefore, the image display regions can be arranged in the center part of the overall liquid crystal display. An electro-optical device can, in addition, perform display hardly causing degraded signal waveforms without generating uneven brightness, as described above.

[0013]

An electro-optical device in accordance with the present invention is characterized by the routing sub-wirings being formed to be independent wirings which are not connected to any one of the electrode means on the substrate formed with the routing sub-wirings.

The routing sub-wirings and the routing wirings are brought into conduction and wiring resistance is reduced. Therefore, the routing sub-wirings need not be connected to the electrode means on the substrate formed with the routing

sub-wirings.

[0014]

An electro-optical device in accordance with the present invention is characterized by the vertical conduction members including a plurality of conductive particles dispersed inside an insulating resin layer.

Specifically, a plurality of conductive particles dispersed inside an insulating resin layer are applicable as vertical conduction members. Those members that are widely utilized as vertical conduction members for liquid crystal displays in general can be utilized. The vertical conduction is easily completed by sandwiching the vertical conduction members with a pair of substrates that press each other, and sandwiching the conductive particles inside thereof with the routing wirings or routing sub-wirings.

[0015]

An electro-optical device in accordance with the present invention is characterized by liquid crystals being sealed between a pair of substrates by a seal layer laid in a peripheral part of the pair of substrates, a part of an area disposed with the seal layer being formed to be a picture-frame area disposed with the routing wirings and the routing sub-wirings, a plurality of conductive particles being dispersed inside the seal layer, and the conductive particles bringing the routing wirings and the routing sub-wirings into vertical conduction.

If members with a plurality of conductive particles dispersed inside the seal layer are used and the seal layer is also arranged in the picture-frame areas formed with the routing wirings, the structure where the seal layer also serves as the vertical conduction members can be adopted.

An electro-optical device in accordance with the present invention is characterized by a gap agent to control a thickness of a liquid crystal layer being dispersed in the seal layer.

When a gap agent is dispersed in the seal layer, the substrates define a cell gap through the gap agent, thus making it possible to secure a uniform cell gap, that is, a uniform liquid crystal layer thickness. When, in addition, a gap agent is dispersed in the seal layer, a uniform cell gap, that is, an uniform liquid crystal layer thickness can be secured with less or no gap agent dispersed in the image display region. The above-mentioned configuration is effective particularly in liquid crystal panels of the type that has no gap agent dispersed in the display region, for example, in small-sized liquid crystal displays such as liquid crystal displays for mobile telephones.

[0016]

An electro-optical device in accordance with the present invention is characterized by the plurality of routing wirings formed on the picture-frame areas including a routing wiring for an electrode means located farther from the drive circuit

means that has a width greater than another routing wiring for another electrode means located closer to the drive circuit means, with the electrode means being connected to the drive circuit means.

When the width of the routing wiring for the electrode means located farther from the drive circuit means is formed to be greater than that of the routing wiring for the electrode means located closer to the drive circuit means, the wiring resistance of the routing wiring for the electrode means located far from the drive circuit means can be lowered, and display with uniform brightness can be performed with respect to the electrode means at any position in the image display regions.

[0017]

An electro-optical device in accordance with the present invention is characterized in that the signal electrode means include a pixel electrode part formed at every pixel and a two-terminal nonlinear element disposed between a signal wiring part and the pixel electrode part. The characteristics of being capable of performing display without generating uneven brightness even though the drive circuit means applies signals to the electrode means at any position in the image display regions can be enjoyed even in a device having two-terminal nonlinear elements.

[0018]

An electronic device according to the present invention is characterized by having any of the electro-optical devices described as a display means and is characterized in that the electronic device can perform display without generating uneven brightness.

[0019]

[Mode for Carrying Out the Invention]

Although embodiments of the present invention will be described with reference to the drawings, the present invention is not limited to the embodiment described below.

[First Embodiment]

FIGS. 1 to 4 depict a first embodiment where the invention is applied to a passive matrix liquid crystal display (electro-optical device). FIG. 1 is a plan view illustrating the whole structure of a liquid crystal display A. FIG. 2 is a plan view illustrating one of substrates of the liquid crystal display A. FIG. 3 is a plan view illustrating the other of the substrates of the liquid crystal display A. FIG. 4 is a sectional view of the structure of a portion of connecting routing wirings and routing sub-wirings. Additionally, in each of the drawings, layers and members are drawn in different scales in order to allow each layer or each member to be recognizable on the drawings.

The liquid crystal display A of this embodiment is disposed with a substrate 1, which is one of the substrates,

facing a substrate 2, which is the other of the substrates. Liquid crystals are sealed between the substrates. More specifically, a seal layer 3 that is located between the substrates 1 and 2, and is arranged in an approximately rectangular shape when viewed in a plane is disposed on the peripheries of the substrates 1 and 2. The liquid crystals are sealed, surrounded by the substrates 1 and 2 and the seal layer 3.

Furthermore, on one part side of the seal layer 3 (on the upper end side in FIG. 1), a filling port 3A to inject liquid crystals is formed so as to reach the ends of the substrates 1 and 2. The filling port 3A is closed with a sealing material 5, and thereby the liquid crystals are sealed.

[0020]

A lateral width of each of the one substrate 1 and the other substrate 2 in a state shown in FIG. 1 (a lateral width of each of the substrates 1 and 2 in a state of being disposed facing each other when viewed in a plane) is set to be equal. A longitudinal width of the one substrate 1 (a longitudinal width shown in FIG. 1) is formed to be slightly longer than the other substrate 2. A one-chip type drive circuit means (drive circuit element) 6 is disposed in an installation area 4 in the center of an end side 1A of the one substrate 1 that is disposed to extend from the other substrate 2. Additionally, as shown in FIG. 1, inside the seal layer 3 in a state that

the substrates 1 and 2 face each other, a plurality of electrodes (electrode means) 13 and a plurality of electrodes (electrode means) 18, which will be described below, are arranged in a matrix shape, and these electrodes form rectangular image display regions GR.

Subsequently, a left-side picture-frame area 8 is formed at the left-side of the image display regions GR shown in FIG. 1. A right-side picture-frame area 9 is formed in at right-side of the image display regions GR. An upper-side picture-frame area 10 is formed at the upper side of the image display regions GR. An under-side picture-frame area 11 is formed at the under-side of the image display regions GR. Among these elements, the picture-frame areas 8 and 9 at the left and right sides of the image display regions GR are formed to have an equal width.

[0021]

Next, the electrode means, the routing wirings and the routing sub-wirings formed on the substrates 1 and 2 will be described in detail. In addition, the electrode means or wirings described below are basically formed of transparent conductive materials, such as an ITO (indium-tin oxide). Needless to say, however, the routing wirings or routing sub-wirings among these elements may be formed of metal wirings for a low resistance.

FIG. 2 is a plan view of a configurational structure of

the electrode means formed on the one substrate 1; eight electrodes (electrode means) 13 in a strip shape of the column side (Y-side) are formed at a predetermined pitch so as to occupy the center of the one substrate 1 in the present embodiment. Additionally, only eight electrodes 13 are shown in FIG. 2 for simplifying the description, but a few tens to a few thousands of electrodes can be arranged according to the screen resolution in an actual liquid crystal display. Furthermore, the area where the electrodes 13 are disposed is to be an area inside the seal layer 3, as shown in FIG. 1.

[0022]

Then, one end side of each of the electrodes 13 (the under end side in FIG. 1 or 2) is connected to the drive circuit element 6 through connecting wirings 15 formed on the substrate 1. Moreover, at the right side of the area for forming the electrodes 13 on the substrate 1 shown in FIG. 2, routing sub-wirings 16 are formed so as to correspond to every other electrodes 18 out of a plurality of electrodes 18 of the row side, which will be described below with reference to FIG. 3, formed on the other substrate 2. At the left side of the area to form the electrodes 13 on the substrate 1, routing sub-wirings 17 are similarly formed so as to correspond to the remaining electrods 18 at the interval of an electrode, which will be described below, formed on the substrate 2. Each of the routing sub-wirings 16 and 17 is connected to the drive

circuit element 6 on the substrate 1.

In addition, each of the routing sub-wirings 16 includes a wiring part 16a extending in the same direction (X-direction) as the electrodes 18 that will be described below based on FIG. 3 to extend in the lateral direction on the substrate 1, an extending part 16b extending in the vertical direction (Y-direction) on the substrate 1 to extend to the end side of the substrate 1 and a connecting part 16c extending from the end of the substrate 1 in the lateral direction (X-direction) to connect to the drive circuit element 6. The routing sub-wirings 17 similarly each include a wiring part 17a, an extending part 17b and a connecting part 17c.

[0023]

FIG. 3 is a plan view of a configurational structure of electrode means formed on the other substrate 2; ten strip-shaped electrodes (electrode means) 18 of the row side (X-side) are formed at a predetermined pitch so as to occupy the center side of the substrate 2 in the embodiment. Additionally, FIG. 3 only illustrates ten electrodes 18 for simplifying the description, but a few tens to a few thousands of electrodes are arranged according to the screen resolution in an actual liquid crystal display. Furthermore, the area where the electrodes 18 are disposed is to be an area inside the seal layer 3 as shown in FIG. 1. In a state that the substrates 1 and 2 overlay and face each other as shown in FIG.

1, the plurality of electrodes 13 and the plurality of electrodes 18 are arranged to be in a matrix shape when viewed in a plane as described previously.

[0024]

Subsequently, the right end side of the other substrate 2 is formed with routing wirings 20 to alternately connect to the ends of the plurality of electrodes 18 in rows. The left end side of the other substrate 2 is also formed with routing wirings 21 to alternately connect to the remaining ends of the plurality of electrodes 18 in rows. The routing wirings 20 include a connecting part 20a connected to the right end of the electrodes 18 to extend in the lateral direction (X-direction) of the substrate 2 and an extending part 20b extending to the end of the other substrate 2 in the longitudinal direction (Y-direction) of the substrate 2. The routing wirings 21 also include a connecting part 21a connected to the left end of the electrodes 18 to extend in the lateral direction of the other substrate 2 and an extending part 21b extending to the end of the substrate 2 in the longitudinal direction of the other substrate 2.

Then, these routing wirings 20 are formed so as to correspond to the routing sub-wirings 16 on the substrate 1 previously described. The routing wirings 21 are formed to correspond to the routing sub-wirings 17 on the substrate 1 previously described. That is, in the state that the

substrates 1 and 2 face each other as shown in FIG. 1, the routing sub-wirings 16 and 17 are so arranged that each of the routing sub-wirings 16 approximately overlaps with each of the routing wirings 20 when viewed in a plane and each of the routing sub-wirings 17 approximately overlaps with each of the routing wirings 21 when viewed in a plane.

[0025]

Subsequently, in the state that the substrates 1 and 2 face each other as shown in FIG. 1, a part of the seal layer 3 is positioned in the portion of the connecting part 20a of each of the routing wirings 20 and the wiring part 16a of each of the routing sub-wirings 16. A part of the seal layer 3 is positioned in the portion of the connecting part 21a of each of the routing wirings 21 and the wiring part 17a of each of the routing sub-wirings 17. Additionally, the extending part 17b of the routing sub-wirings 17 and the extending part 21b of the routing wirings 21 are mainly disposed in the picture-frame area 8 at the left side of the image display regions GR. The extending part 16b of the routing sub-wirings 16 and the extending part 20b of the routing wirings 20 are mainly disposed in the picture-frame area 9 at the right side of the image display regions GR.

[0026]

Then, in a portion corresponding to the picture-frame area 8 and a portion corresponding to the picture-frame area

9 between the substrates 1 and 2, a vertical conduction member 25 is laid in the outside areas of the seal layer 3 (portions shaded in each of the outside areas in FIG. 1). The vertical conduction members 25 include a plurality of conductive particles 27 dispersed inside an insulating resin layer 26 with an insulating property. Any of a metal ball with a particle diameter of a few [u]m, a spherical conductive polymer ball and a spherical polymer ball with a metal-coated surface may be used as the conductive particle 27. Specifically, when the substrates 1 and 2 facing each other are bonded to each other to be combined, with the vertical conduction members 25 laid in the picture-frame areas 8 and 9 in both the substrates, the extending parts 16b and 20b or the extending parts 17b and 21b formed in the substrates 1 and 2 sandwich the conductive particles 27, as shown in FIG. 3, thereby allowing electrical vertical conduction. In addition, similarly, the vertical conduction members 25 also performs electrical connection in the wiring parts 16a and 17a of the routing sub-wirings 16 and 17 and the extending parts 20a and 21a of the routing wirings 20 and 21 in the picture-frame areas 8 and 9.

Accordingly, electrical vertical conduction is established between each of the routing wirings 20 and each of the routing sub-wirings 16 that face each other with the substrates 1 and 2 viewed in a plane, and between each of the routing wirings 21 and each of the routing sub-wirings 17 facing

each other.

[0027]

Furthermore, in the case of the actual liquid crystal display, a polarizer or retardation film is disposed outside the substrates 1 and 2. However, the illustration and description of these members are omitted in the present embodiment. A backlight is disposed on the backside of the substrate when the liquid crystal display is a transmissive type, a reflective layer is disposed when it is a reflective type, and a color filter is disposed when it is a color display type. However, the description of these components is omitted in the case of the embodiment.

[0028]

In the liquid crystal display A configured as described above, the drive circuit element 6 supplies image signals and scanning signals to each of the electrodes 13 and 18 at a predetermined timing to drive these electrodes 13 ... and 18... Thereby, alignment conditions of liquid crystal molecules laid between the crossed portions of these electrodes are controlled to allow the display to be controlled.

Then, when the drive circuit element 6 applies voltage to each electrode 18 ... in order to drive the electrodes 18 in rows such that the same voltage is applied to the electrode means 18 located closer to the drive circuit element 6 and the electrode 18 located farther from the drive circuit element

6, the routing wirings 20 and the routing sub-wirings 16 brought into vertical conduction by the vertical conduction members 25 in the picture-frame area 8 and the routing wirings 21 and the routing sub-wirings 17 brought into vertical conduction by the vertical conduction members 25 in the picture-frame area 9, exist between the drive circuit element 6 and the electrodes 18. Thus, resistance of the whole routing wirings including these elements can be lower than that of the structure shown in FIG. 11, and as a result, a targeted voltage can surely be applied to the electrodes 18 at any position to drive them. Accordingly, display with uniform brightness can be attained even in a part of the image display regions GR corresponding to the electrode 18 farther from the drive circuit element 6 and in a part of the image display regions GR corresponding to the electrode 18 located closer to the drive circuit element 6.

Then, in the device of the embodiment, the picture-frame areas 8 and 9 with almost an equal width are formed at the left and right sides of the image display regions GR. Therefore, the image display regions GR can be arranged in the center part of the overall liquid crystal display.

[0029]

Additionally, in the embodiment, the width for each of the routing wirings 20 and 21 and the routing sub-wirings 16 and 17 is not defined particularly, but it may be set to have

an equal width or an unequal width. When it is set to have an unequal width, such a structure may be adopted that the routing wirings 20 and 21 to be connected to the electrode 18 located the nearest to the drive circuit element 6 are formed to be the narrowest, the width of the routing wirings 20 and 21 is set to be greater for the routing wiring connected to an electrode 18 located farther from the drive circuit element 6; and the routing wirings 20 and 21 located farthest from the drive circuit element 6 are formed to be the widest. Additionally, the routing wirings 20 and 21 and the routing sub-wirings 16 and 17 may be formed of metal wirings. When they are formed of metal wirings, they can be formed to have resistance lower than that of transparent conductive materials such as an ITO. Thus, the width of wirings itself can be formed into a fine line, which enables a further narrower picture frame.

Furthermore, in the embodiment, the routing wirings 20 and 21 are connected to the electrodes 18 at the interval of an electrode. However, the methods and devices to connect these elements are not limited; and they may be connected at every multiple electrodes, for example.

[0030]

<Second Embodiment>

FIGS. 5(a), 5(b) and 5(c) depict a second embodiment where the invention is applied to a passive matrix liquid

crystal display (electro-optical device). FIG. 5(a) is a schematic plan view illustrating a liquid crystal display of the embodiment. FIG. 5(b) is a schematic plan view illustrating electrodes and routing wirings on one of substrates of the liquid crystal display. FIG. 5(c) is a schematic plan view illustrating electrodes and routing wirings on the other of the substrates of the liquid crystal display. Additionally, in each of the drawings, layers and members are drawn in different scales in order to allow each layer and each member to recognizable on the drawings.

A liquid crystal display B of the second embodiment is one example of a liquid crystal display in which the wiring structures are reversed between one substrate side and the other substrate side of the liquid crystal display A of the first embodiment. Thus, the same components are provided with the same reference numerals, and the description thereof is simplified.

Furthermore, in the second embodiment, the structure, where a substrate 31, one of the substrates, faces a substrate 32, the other of the substrates, to hold liquid crystals therebetween, and a seal layer is disposed between the substrates, is the same as the first embodiment. Thus, FIG. 5(a) depicts only a principal part of the electrodes and the wiring structure. FIG. 5(b) depicts the only configurational structure of the electrodes and the routing wirings on the

substrate 31. FIG. 5(c) depicts the only configurational structure of the electrodes and the routing wirings on the substrate 32. The description and explanation of the detailed structure of the portions such as the seal layer are omitted.

[0031]

As shown in FIG. 5(b), the substrate 31 is formed with a plurality of electrodes 33 in rows at a predetermined pitch. As shown in FIG. 5(c), the substrate 32 is formed with a plurality of electrodes 35 in columns at a predetermined pitch. In a state that the substrate 31 faces the substrate 32 as shown in FIG. 5(a), the plurality of electrodes 33 and the plurality of electrodes 35 are so configured that they are arranged in a matrix shape when viewed in a plane to configure image display regions GR.

In a picture-frame area 38 at the right side of the image display regions GR of the substrate 31, routing wirings 40 for electrodes are disposed to connect to the right end of the electrodes 33 at the interval of an electrode. In a picture-frame area 39 at the left side of the image display regions GR, routing wirings 41 are disposed to connect to the left end part of the remaining electrodes 33 at the interval of an electrode. As with the case of the routing wirings of the first embodiment, each of the routing wirings 40 includes a connecting part 40a extending along the electrodes 33 in the lateral direction to connect to the end part of the electrodes

33, an extending part 40b extending in the longitudinal direction of the substrate 32 and a connecting part 40c extending in the lateral direction of the substrate 32 to connect to the drive circuit element 6. Each of the routing wirings 41 also include a connecting part 41a, an extending part 41b and a connecting part 41c.

[0032]

Subsequently, the picture-frame area 38 at the right side of the electrode means 35 on the substrate 32 shown in FIG. 5(c) is formed with routing sub-wirings 43 that include a wiring part 43a in the same form as the connecting part 40a of the routing wirings 40, and an extending part 43b extending in the same direction as the extending part 40b. The picture-frame area 39 on the left side of the substrate 32 is also formed with routing sub-wirings 44 that include a wiring part 44a in the same form as the connecting part 41a of the routing wirings 41 and an extending part 44b extending in the same direction as the extending part 41b.

Accordingly, as shown in FIG. 5(a), the routing wirings 40 overlap with the routing sub-wirings 43 when viewed in a plane in the state that the substrates 31 and 32 face each other, and the routing wirings 41 overlap with the routing sub-wirings 44 when viewed in a plane. Then, as with the case of the first embodiment, a vertical conduction member 25 disposed between the picture-frame areas 38 and 39 on both sides of the

substrates 31 and 32 allows conduction between the routing wirings 40 and the routing sub-wirings 43, and between the routing wirings 41 and the routing sub-wirings 44.

Additionally, on the under end side of the electrodes 35 in columns on the substrate 32, a plurality of connecting wirings 45 that is connected to each of the electrodes 35 and extended to the end side of the substrate 31 is formed. These connecting wirings 45 are connected to connecting wirings 47 connected to a drive circuit element 6 on the first substrate 31 through a vertical conduction member 48.

[0033]

The liquid crystal display B with the substrates 31 and 32 of the structure shown in FIG. 5(a) can also attain the same advantages as the liquid crystal display A of the first embodiment.

That is, in the liquid crystal display configured as described above, the drive circuit element 6 supplies image signals and scanning signals to each of the electrodes 33 and 35 at a predetermined timing to drive the electrodes. Thereby, the alignment of liquid crystals between the electrodes is controlled to allow the display to be controlled.

Then, when the drive circuit element 6 applies voltage to each electrode 33 in order to drive the electrodes 33 ... in rows such that voltage is applied to the electrode 33 located closer to the drive circuit element 6 and the electrode 33

located farther from the drive circuit element 6, the routing wirings 40 and the routing sub-wirings 43 brought into vertical conduction by the vertical conduction members 25 in the picture-frame area 38 or the routing wirings 41 and the routing sub-wirings 44 brought into vertical conduction by the vertical conduction members 25 in the picture-frame area 39 exist between the drive circuit element 6 and the electrode 33. Thus, wiring resistance of these elements can be lower than that of the structure shown in FIG. 11, and as a result, a targeted voltage can surely be applied to the electrode means 33 at any position to drive them. Accordingly, uniform brightness can also be attained at a part of the image display regions GR where the electrode 33 far from the drive circuit element 6 is positioned.

Then, the same effect as the first embodiment can be attained in that the image display regions GR can be arranged in the center part of the overall liquid crystal display because the picture-frame areas 38 and 39 with almost an equal width are formed at the left and right sides of the image display regions.

[0034]

<Third Embodiment>

FIG. 6 is a plan view illustrating a third embodiment where the invention is applied to a passive matrix liquid crystal display (electro-optical device). Additionally, in

FIG. 6, layers and members are drawn in different scales in order to allow each layer and each member to be recognizable on the drawings.

A liquid crystal display C of the third embodiment has almost the same wiring structure of the liquid crystal display A of the first embodiment, but it is one embodiment of the structure where the position of forming a seal layer is widely disposed to extend to picture-frame areas and the seal layer is provided with a function of enabling vertical conduction.

Furthermore, in the third embodiment, the structure where a substrate 1, which is one of the substrates, faces a substrate 2, which is the other of the substrates, to hold liquid crystals therebetween, and the seal layer is disposed between the substrates is the same as the first embodiment. Therefore, the description for these portions is omitted.

[0035]

The third embodiment employs a structure where conductive particles are dispersed inside a seal layer 53, and the seal layer 53 also serves as a vertical conduction member.

That is, the seal layer 53 is expanded to have extending parts 53A and 53B extending to picture-frame areas 8 and 9 on the left and right sides of the substrates 1 and 2.

The structure of the other portions is the same as the liquid crystal display A of the first embodiment. Thus, the same portions are designated the same reference numerals and

signs, omitting the description of the same portions.

[0036]

The liquid crystal display C having the substrates 1 and 2 and the seal layer 53 of the structure shown in FIG. 6 can also attain the same operation and effect as the liquid crystal display A of the first embodiment.

That is, in the liquid crystal display C configured as described above, a drive circuit element 6 supplies image signals and scanning signals to each of electrodes 13 and 18 at a predetermined timing to drive the electrodes. Thereby, the alignment of liquid crystals between the electrodes is controlled to allow the display to be controlled.

Then, when the drive circuit element 6 applies voltage to each electrode 18 in order to drive the electrodes 18 ... in rows such that the same voltage is applied to the electrode 18 located closer to the drive circuit element 6 and the electrode 18 located farther from the drive circuit element 6, routing wirings 20 and routing sub-wirings 16 brought into vertical conduction by the seal layer 53A in the picture-frame area 8 or routing wirings 21 and routing sub-wirings 17 brought into vertical conduction by the seal layer 53B in the picture-frame area 9 exist between the drive circuit element 6 and the electrodes 18. Thus, wiring resistance of these elements can be lower than that of the structure shown in FIG. 11, and as a result, a targeted voltage can surely be applied

to the electrodes 18 at any position to drive them. Accordingly, uniform brightness can be attained also at a part of the image display regions GR corresponding to the electrode 18 located farther from the drive circuit element 6 and a part of the image display regions GR corresponding to the electrodes 18 located closer to the drive circuit element 6.

Then, the picture-frame areas 8 and 9 with almost an equal width are formed at the left and right sides of the image display regions GR. Therefore, the image display regions GR can be arranged in the center part of the overall liquid crystal display.

In this case, the vertical conduction between the routing wirings 20 and 21 and the routing sub-wirings 16 and 17 is established at the same time when the seal layer 53 is formed shown in FIG. 6. The manufacturing processes is further simplified. Thus, there is the effect of reducing manufacture costs of the overall device. Additionally, a liquid crystal display is fabricated in a manner that balls such as silica (SiO_2), called a gap agent, are dispersed to uniformly control a thickness of a liquid crystal layer and pressure is applied to the substrates 1 and 2 to form a specific cell gap. However, the balls such as silica cannot control light.

On this account, when a uniform gap (a thickness of the liquid crystal layer) is to be obtained, the gap agent needs to be dispersed a great deal, but the display quality is

degraded as more of the gap agent is dispersed. The gap agent is mixed into the seal layer 53 with conductive particles 27, and thereby the gap agent in the image display regions GR can be reduced. Accordingly, a light control area of the image display regions GR is increased and the high-quality display can be performed. In a liquid crystal display applied to a mobile telephone or the like, the image display regions GR are small. Thus, the gap agent only in the seal layer can sufficiently secure the thickness accuracy of the liquid crystal layer without dispersing the gap agent in the regions. In this case, the manufacturing process to disperse the gap agent is also omitted, and further cost saving can be attained.

[0037]

FIG. 7 depicts a fourth embodiment of a liquid crystal display (electro-optical device) in accordance with the invention. The embodiment shows a structure where routing wirings are only disposed at one side (on the left side in the drawing), and not evenly disposed at both the left and right sides of the image display regions GR.

In the liquid crystal display (electro-optical device) D of the fourth embodiment, the picture-frame area 8 is omitted, which is disposed at the right side of the seal layer 3 in the first embodiment. Instead, a picture-frame area 58 at the left side of the seal layer 3 is formed to have a width wider than that of the first embodiment. Then, routing wirings 21 to be

connected to electrodes 18 in rows are disposed so that each of the routing wirings 21 is connected to each of all the electrodes 18, not at the interval of an electrode. Similarly, routing sub-wirings 17 are formed corresponding to all the routing wirings 21. Instead, a picture-frame area at the right side of the image display regions GR is not formed with the routing wirings and the routing sub-wirings.

The rest of the structure is the same as the first embodiment.

[0038]

In the liquid crystal display D having the picture-frame area 58, the routing wirings 17 and the routing sub-wirings 21 of the structure shown in FIG. 7, the image display regions GR cannot be disposed in the center part of the device, but except that, the same operation and effect as the liquid crystal display A of the first embodiment can be attained.

That is, when a drive circuit element 6 applies voltage to each electrode 18 in order to drive the electrodes 18 ... in rows such that voltage is applied to the electrode 18 located closer to the drive circuit element 6 and the electrode 18 located farther from the drive circuit element 6, the routing wirings 21 and the routing sub-wirings 17 brought into vertical conduction by a vertical conduction member 25 in the picture-frame area 58 exist between the drive circuit element 6 and the electrodes 18. Thus, wiring resistance can be lower

than that of the structure shown in FIG. 11, and as a result, a targeted voltage can surely be applied to the electrodes 18 at any position to drive them. Accordingly, uniform brightness can also be attained in the image display regions GR far from the drive circuit element 6 and in the image display regions GR near the drive circuit element 6.

[0039]

Meanwhile, in the embodiments described above, the examples where the invention is applied to the passive matrix liquid crystal display have been described. Needless to say, however, the invention can be applied to an active matrix liquid crystal display (electro-optical device) where a two-terminal linear element serves as a switching element.

FIG. 8 is a partial perspective view of a principal part of a wiring circuit in an image display region of the active matrix liquid crystal display including the two-terminal linear element of this type serving as the switching element. The embodiment is configured in which a substrate 62 on the element side faces a counter substrate 61 through a predetermined cell gap, and liquid crystals, not shown in FIG. 8, are sealed between the substrates 61 and 62, and a plurality of strip-shaped scanning electrodes (electrode means) 64 is formed on the counter substrate 61 at a predetermined pitch.

[0040]

Additionally, the substrate 62 on the element side is

formed with an insulating film 71, a plurality of signal lines 72 formed at a predetermined pitch and a plurality of thin film diodes 73. Among these elements, the signal lines 72 are disposed orthogonal to the scanning electrode means 64 at a predetermined pitch. A plurality of pixel electrodes (electrode means) 74 is arranged between the adjacent scanning electrode means 64. Areas where the plurality of the scanning electrodes 64 crosses the plurality of signal lines 72 when viewed in a plane are to be image display regions.

Furthermore, the thin film diodes 73 are provided with a flake-shaped element part 74a extended from the signal line 72 to the pixel electrode 74 side, and an insulating film is formed on the element part 74a. Then, a conductive film 75 is formed so as to cover the element part 74a and partially overlap the pixel electrode 74.

Moreover, a color filter and a black matrix are formed on the counter substrate 61 when the liquid crystal display is a color display convertible type, but FIG. 8 omits these elements.

[0041]

Also in the liquid crystal display configured as described above, the plurality of scanning electrodes (electrode means) 64 is formed at a predetermined pitch, and each of the scanning electrodes 64 is connected to the drive circuit element disposed on the substrate. Thus, the

structure of the invention can be applied to the routing wirings to be connected to the end of the scanning electrode 64 as with the case of the first embodiment. That is, assuming that the plurality of the electrodes 18 shown in FIG. 1 is considered to be the scanning electrode 64 in the embodiment, the routing wirings are disposed in a picture-frame area of the substrate 61, the routing sub-wirings are formed in a picture-frame area of the substrate 62 and the routing wirings are connected to the routing sub-wirings by a vertical conduction member provided between the picture-frame areas of the substrates 61 and 62. The routing wirings can be formed to have a lower resistance, and the same effective voltage can be applied to the electrode located farther from the drive circuit element and the electrode located closer to the drive circuit element as with the case of the first embodiment.

[0042]

<Embodiment of Electronic Devices>

Next, specific examples of electronic devices including any one of the liquid crystal displays (electro-optical devices) of the first to fifth embodiments will be described.

FIG. 9(a) is a perspective view illustrating one example of a mobile telephone.

In FIG. 9(a), reference numeral 500 denotes a mobile telephone main body, and reference numeral 501 denotes a liquid crystal display unit using any one of the aforementioned liquid

crystal displays.

FIG. 9(b) is a perspective view illustrating one example of a mobile information processing unit, such as a word processor or personal computer.

In FIG. 9(b), reference numeral 600 denotes an information processing unit, reference numeral 601 denotes an input part such as a keyboard, reference numeral 603 denotes an information processing unit main body, and reference numeral 602 denotes a liquid crystal display unit using any one of the liquid crystal displays.

FIG. 9(c) is a perspective view illustrating one example of a wristwatch-type electronic device.

In FIG. 9(c), reference numeral 700 denotes a watch main body, and reference numeral 701 denotes a liquid crystal display unit using any one of the liquid crystal displays.

Each of the electronic devices shown in FIGS. 9(a) to 9(c) is equipped with the liquid crystal display unit using any one of the liquid crystal displays. Thus, they perform an evenly bright display mode and include the narrow picture-frame areas provided evenly at the left and right sides of the image display regions, providing high display quality.

[0043]

[Advantages of the Invention]

As described above, according to the invention, the routing wirings and the routing sub-wirings are formed to face

each other in the picture-frame areas outside the image display regions on the substrates facing each other and are connected by the vertical conduction members. Thus, wiring resistance can be lowered than in the case of the wiring only with the routing wirings.

Accordingly, the structure of the invention has a feature that can perform display hardly causing degraded signal waveforms without generating uneven brightness, even though the drive circuit means applies signals to the scanning electrode means or signal electrode means at any position in the image display regions.

[0044]

According to the invention, the picture-frame areas with an equal width are formed at the left and right sides of the image display regions and thus the image display regions can be arranged in the center part of the device. Further, the electro-optical device can be provided that can perform display hardly causing degraded signal waveforms without generating uneven brightness as described previously.

[0045]

According to the invention, specifically as the vertical conduction members, members with a plurality of conductive particles dispersed inside the insulating resin layer can be employed. If this structure is employed, however, those members that are widely utilized as vertical conduction members

for liquid crystal displays in general can be utilized. The vertical conduction is easily completed by sandwiching the vertical conduction members with a pair of substrates that press each other, and sandwiching the conductive particles inside thereof with the routing wirings or routing sub-wirings.

[0046]

In the invention, a part of the area disposed with the seal layer is formed to be the picture-frame areas to provide the routing wirings and the routing sub-wirings. The plurality of conductive particles is dispersed inside the seal layer to bring the routing wirings and the routing sub-wirings into vertical conduction. The structure where the seal layer also serves as the vertical conduction members can be adopted.

[0047]

In the invention, when the width of the routing wiring for the electrode means located farther from the drive circuit means is formed to be greater than that of the routing wiring for the electrode mean located closer to the drive circuit means, the wiring resistance of the routing wiring for the electrode means located far from the drive circuit means can be lowered, and display with uniform brightness can be performed with respect to the electrode means at any position in the image display regions.

[0048]

The invention can also be applied to the configuration

where the signal electrode means includes a pixel electrode part formed at every pixel and a two-terminal nonlinear element disposed between a signal wiring part and the pixel electrode part. A device can be provided that can perform display without generating uneven brightness even though the drive circuit means applies signals to the electrode means at any position in the image display regions.

[0049]

The electronic devices of the invention include any one of the electro-optical devices described above as a display, for example. Thus, they have a feature of being capable of performing display with no uneven brightness.

[Brief Description of the Drawings]

FIG. 1 is a plan view illustrating the schematic structure of a liquid crystal display of a first embodiment in accordance with the present invention;

FIG. 2 is a plan view illustrating one of the substrates of the same liquid crystal display;

FIG. 3 is a perspective view illustrating the other of the substrates of the same liquid crystal display;

FIG. 4 is a sectional view of the connecting portion of the routing wirings and the routing sub-wirings of the liquid crystal display;

FIGS. 5(a), 5(b) and 5(c) are plan views illustrating the liquid crystal display of a second embodiment; wherein FIG.

5(a) is a schematic plan view of the liquid crystal display; FIG. 5(b) is a schematic plan view illustrating the electrode means and the routing wirings on one of the substrates; and FIG. 5(c) is a perspective view illustrating the electrode means and the routing wirings on the other of the substrates;

FIG. 6 is a plan view illustrating the schematic structure of the liquid crystal display of a third embodiment in accordance with the present invention;

FIG. 7 is a plan view illustrating the schematic structure of the liquid crystal display of a fourth embodiment in accordance with the present invention;

FIG. 8 is a partial sectional view illustrating the schematic structure of the image display region on the substrate of the liquid crystal display of a fifth embodiment in accordance with the present invention;

FIGS. 9(a), 9(b) and 9(c) are perspective views illustrating application examples of the electronic apparatus equipped with the electro-optical device in accordance with the invention; wherein FIG. 9(a) is a perspective view of a mobile telephone; FIG. 9(b) is a perspective view of a mobile information terminal; and FIG. 9(c) is a perspective view of a wristwatch-type electronic device;

FIGS. 10(a) and 10(b) are views of one example of a related art liquid crystal display; wherein FIG. 10(a) is a plan view illustrating the configurational structure of the electrode

arranged in a matrix shape; and FIG. 10(b) is a cross-sectional view; and

FIG. 11 is a plan view illustrating one example of the liquid crystal display proposed by the inventors.

[Description of the Reference Numerals and Signs]

GR: Image display region

1, 2: Substrate

3: Seal layer

6: Drive circuit element (Drive circuit means)

8, 9: Picture-frame area

13, 18: Electrode (Electrode means)

16, 17: Routing sub-wiring

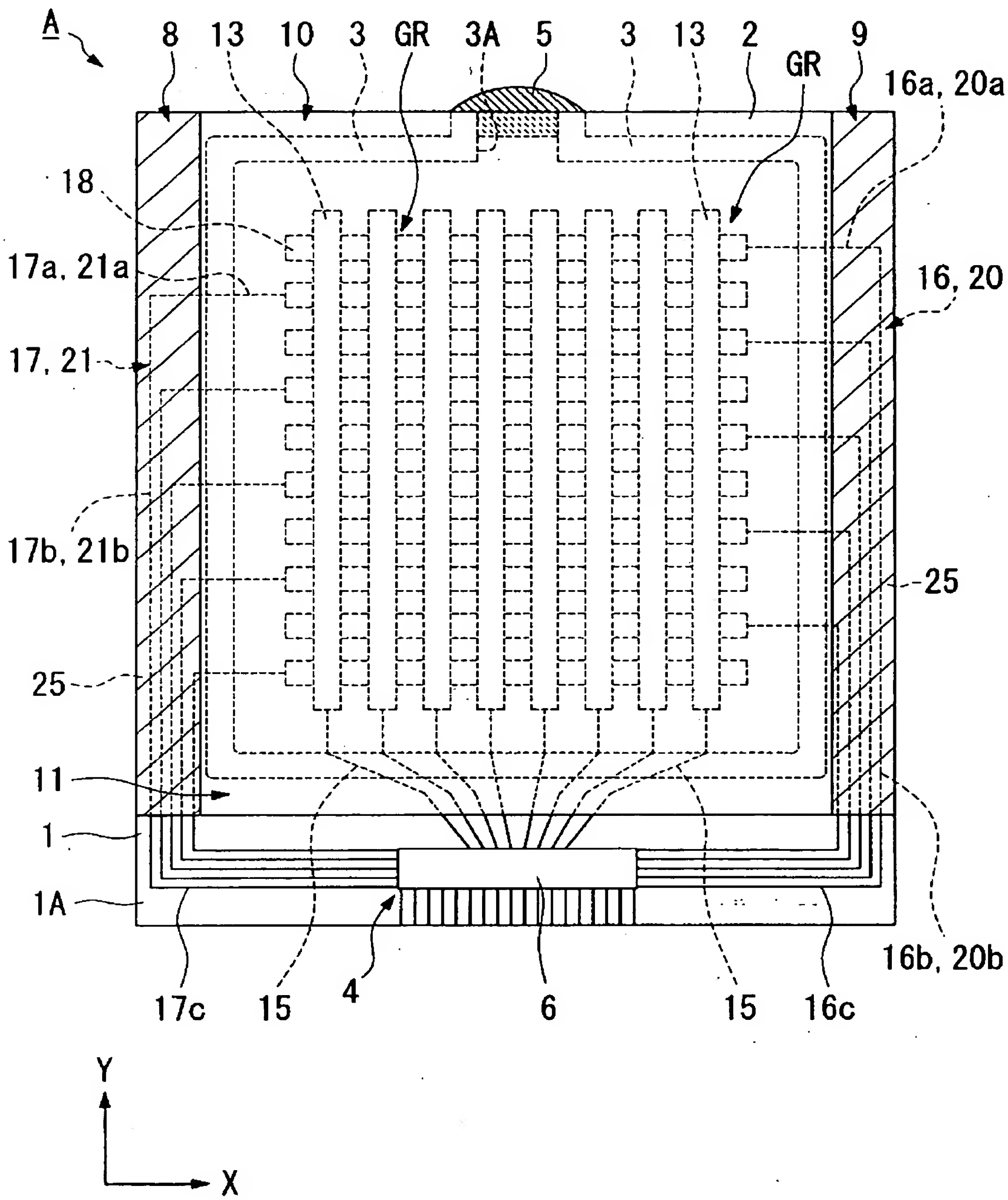
20, 21: Routing wiring

25: Vertical conduction member

26: Insulating resin layer

27: Conductive particle

FIG.1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17b, 21b
25
25
11
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16b, 20b
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15
4
6
15
16c
Y
X

FIG.2

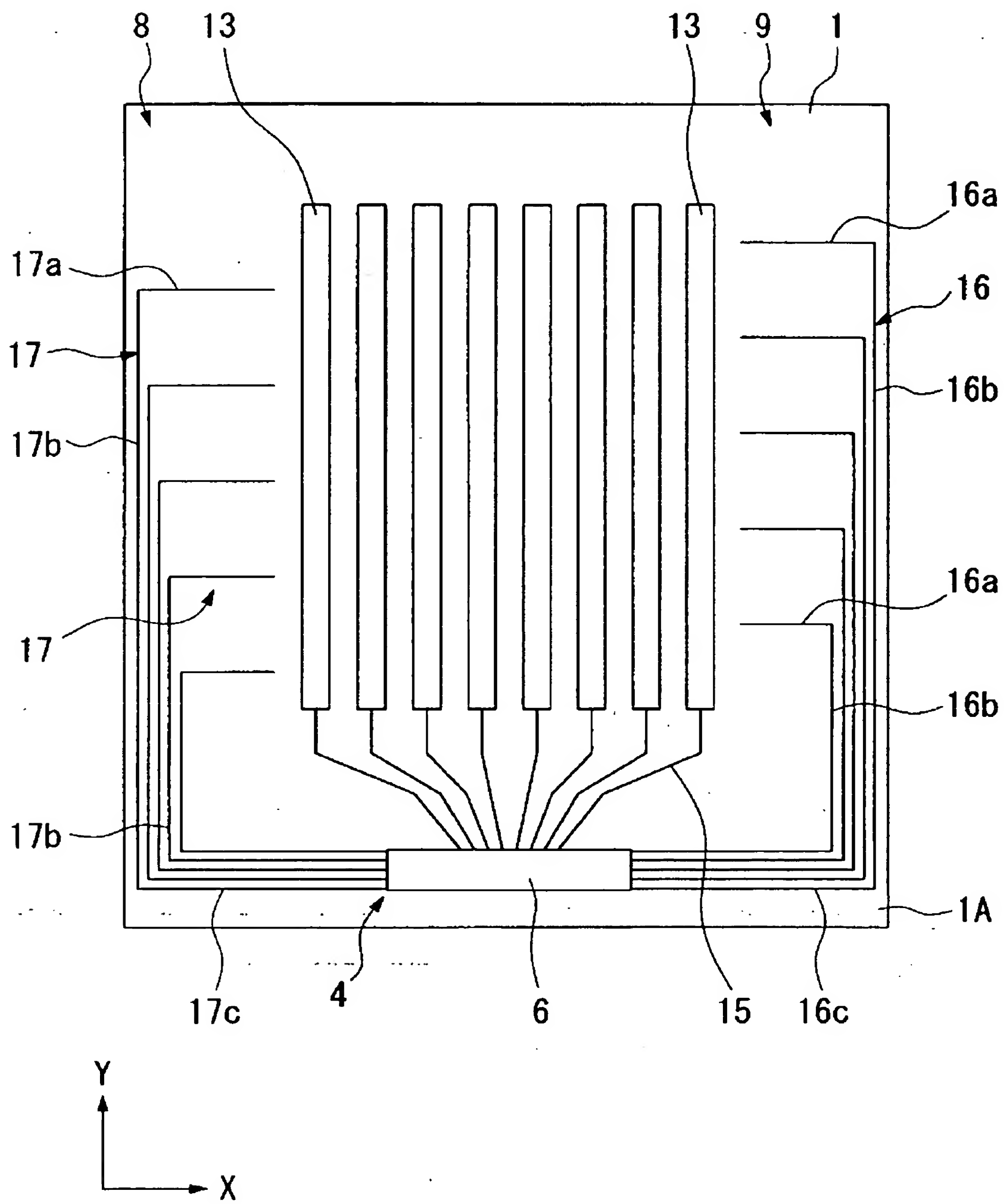


FIG.3

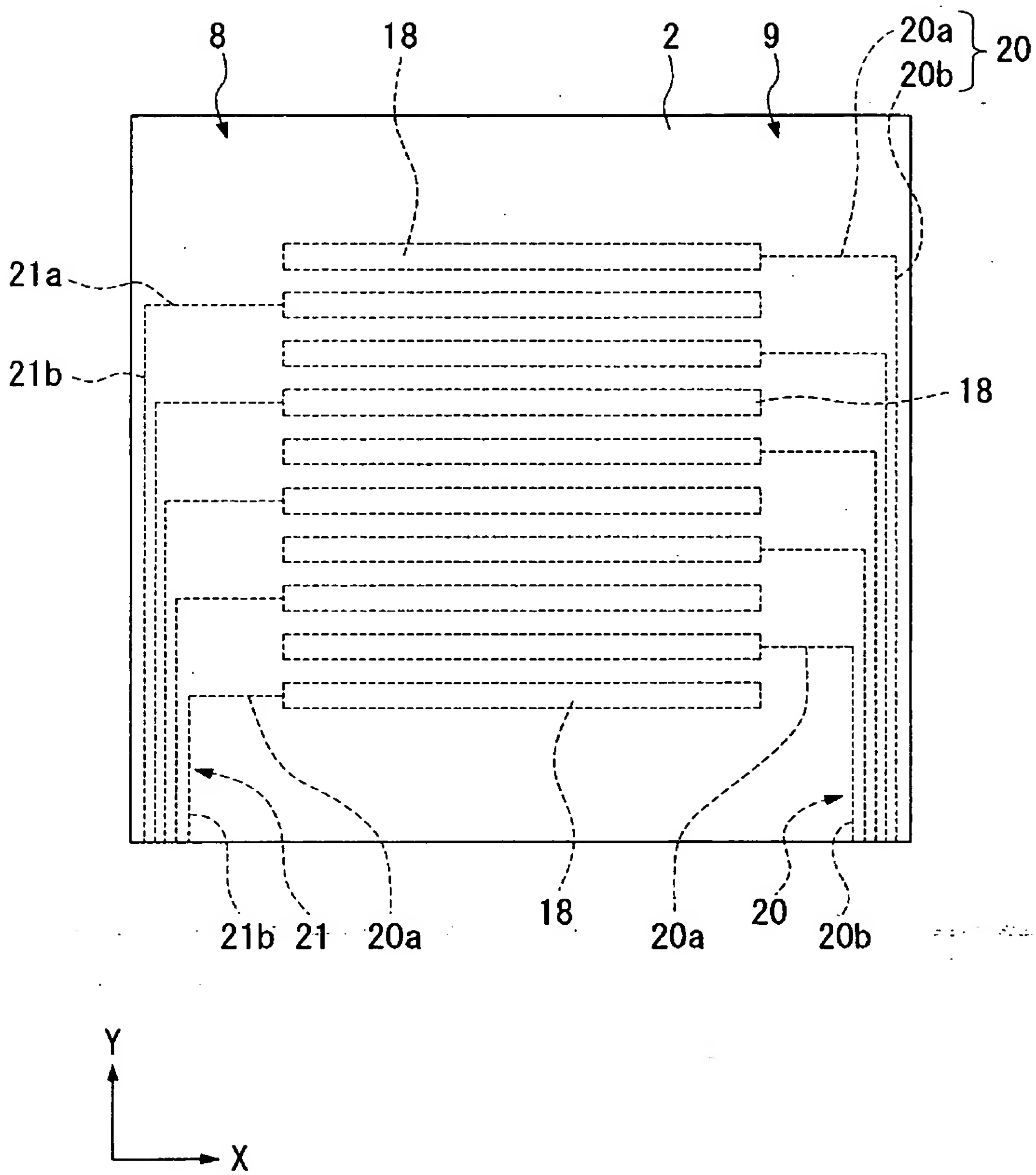


FIG.4

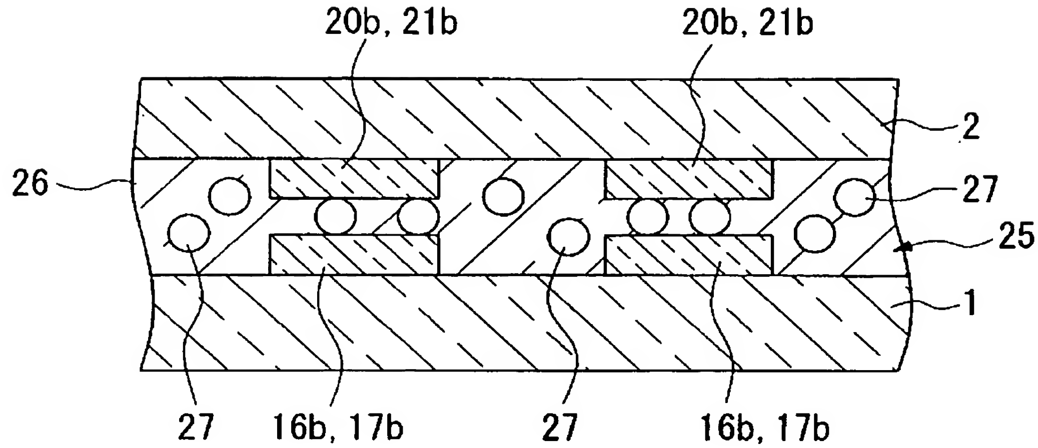
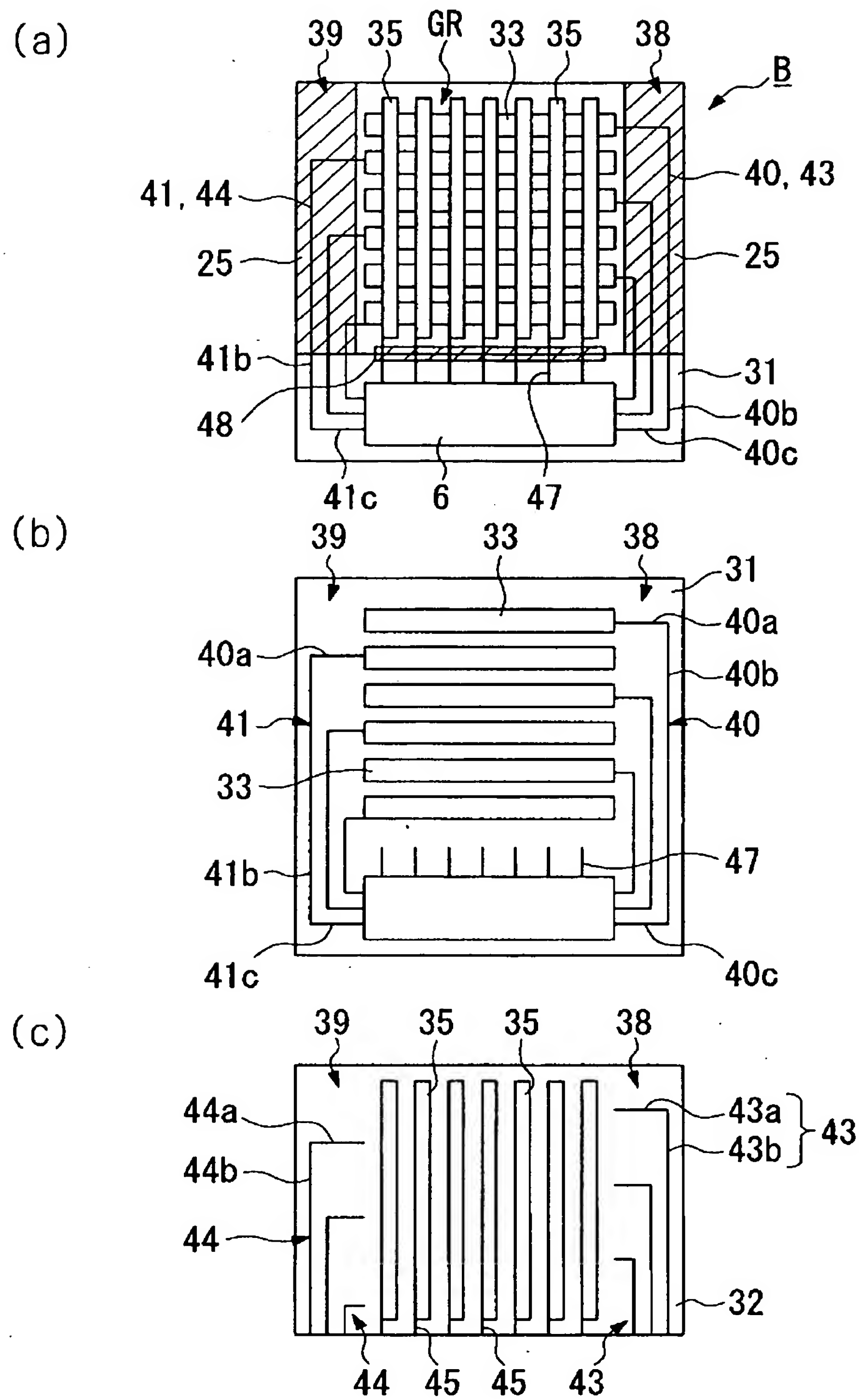


FIG.5


(a)
39
35
GR
33
35
38
B
41, 44
40, 43
25
25
41b
31
48
40b
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6
47
(b)
39
33
38
31
40a
40a
40b
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40
33
41b
47
41c
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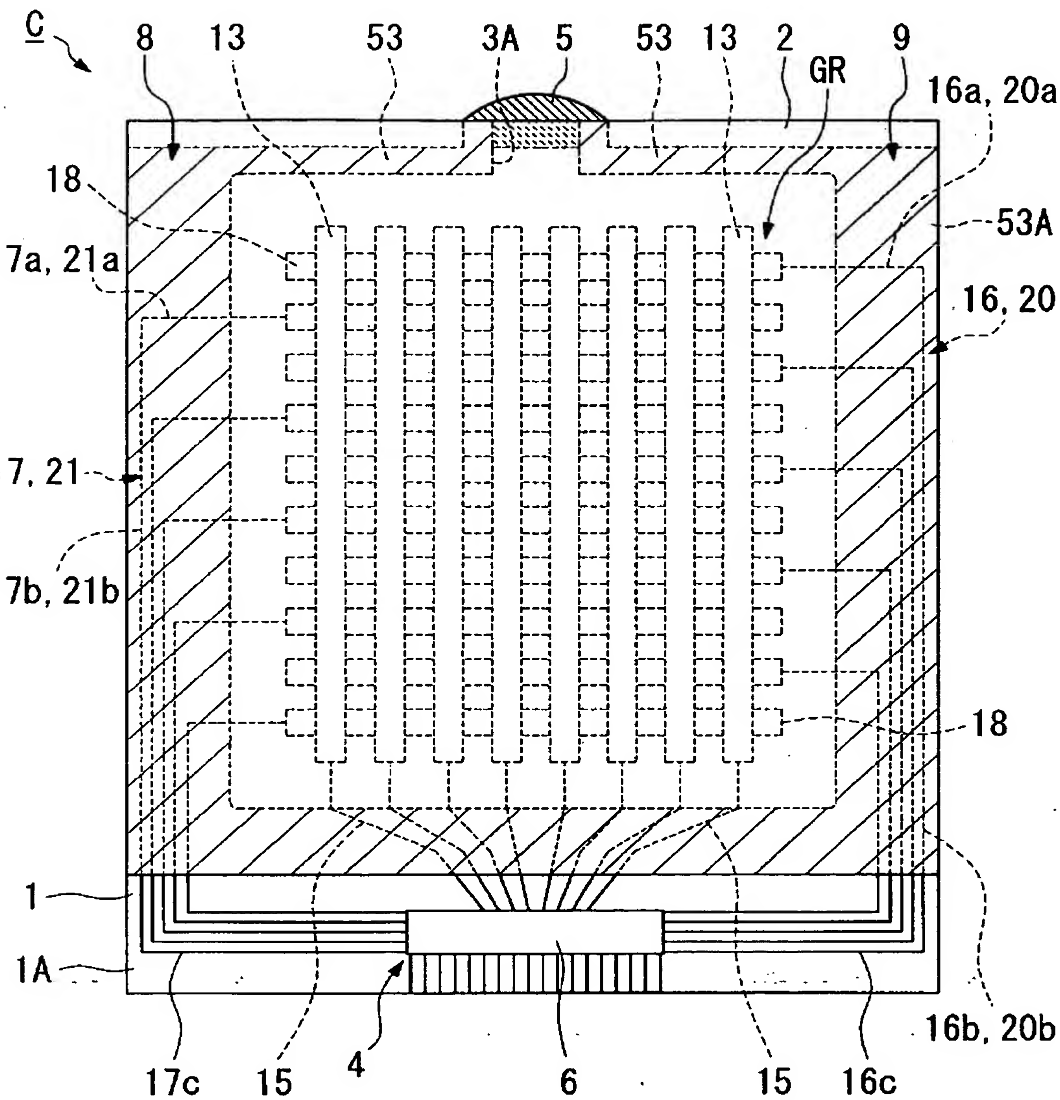
44
45
45
43

FIG.6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3A
5
53
13
2
GR
9
16a, 20a
18
53A
17a, 21a
16, 20
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17b, 21b
18
1
1A
16b, 20b
17c
15
4
6
15
16c

FIG.7

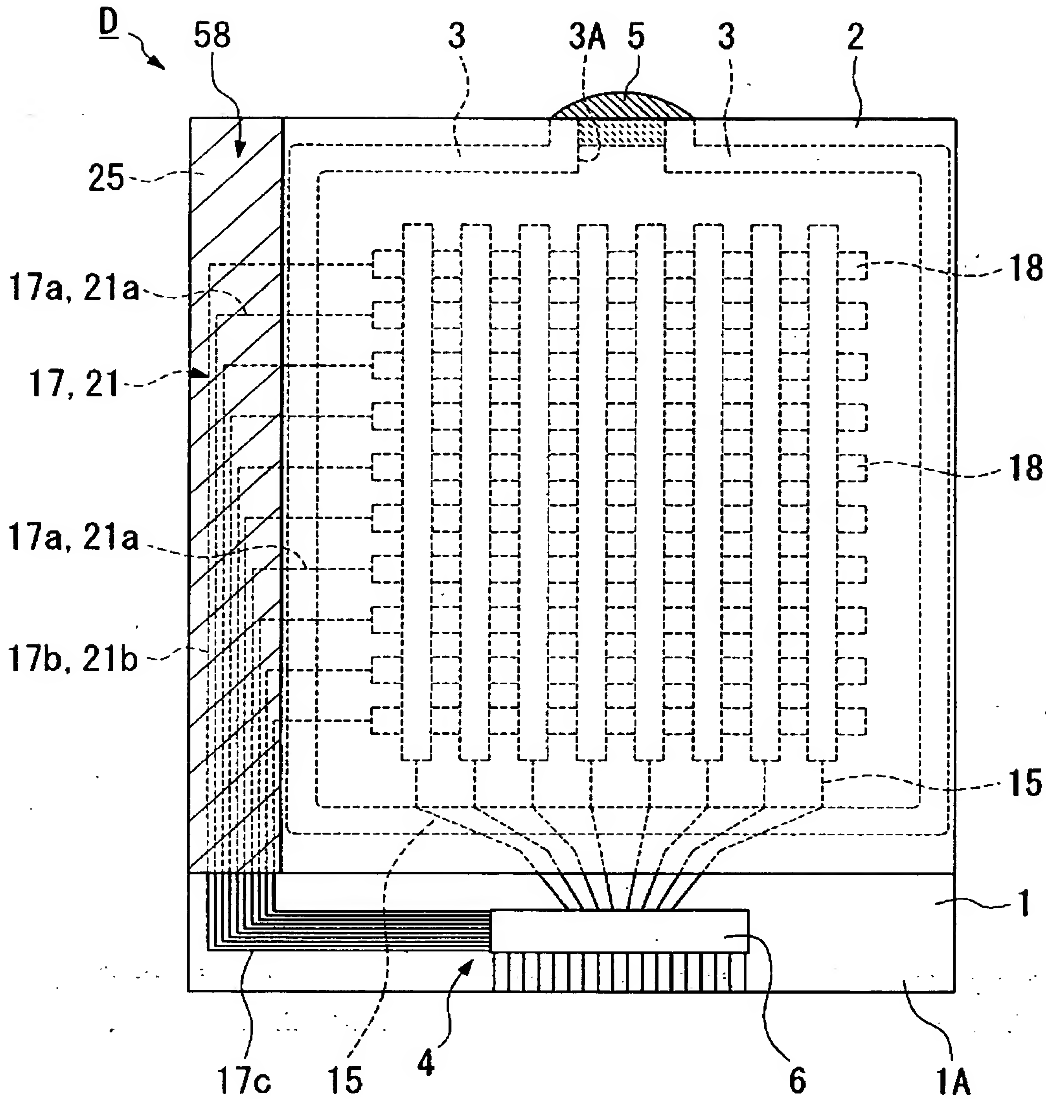


FIG.8

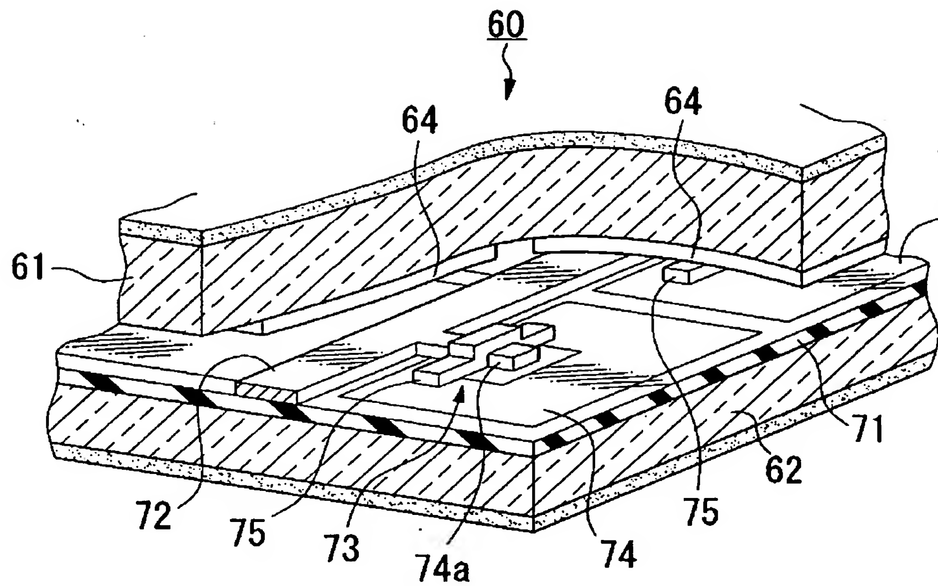
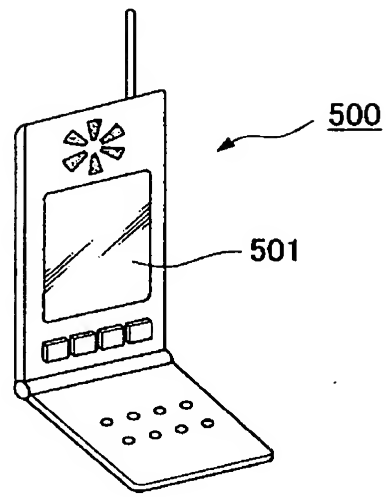
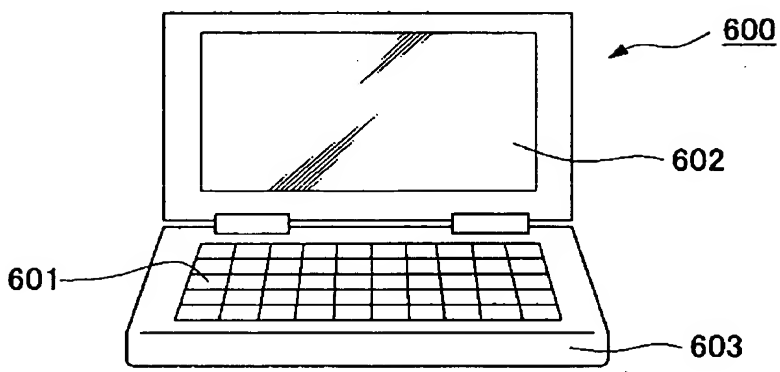


FIG.9

(a)



(b)



(c)

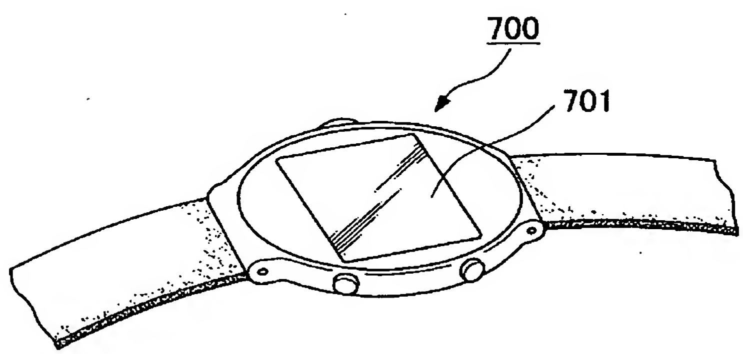
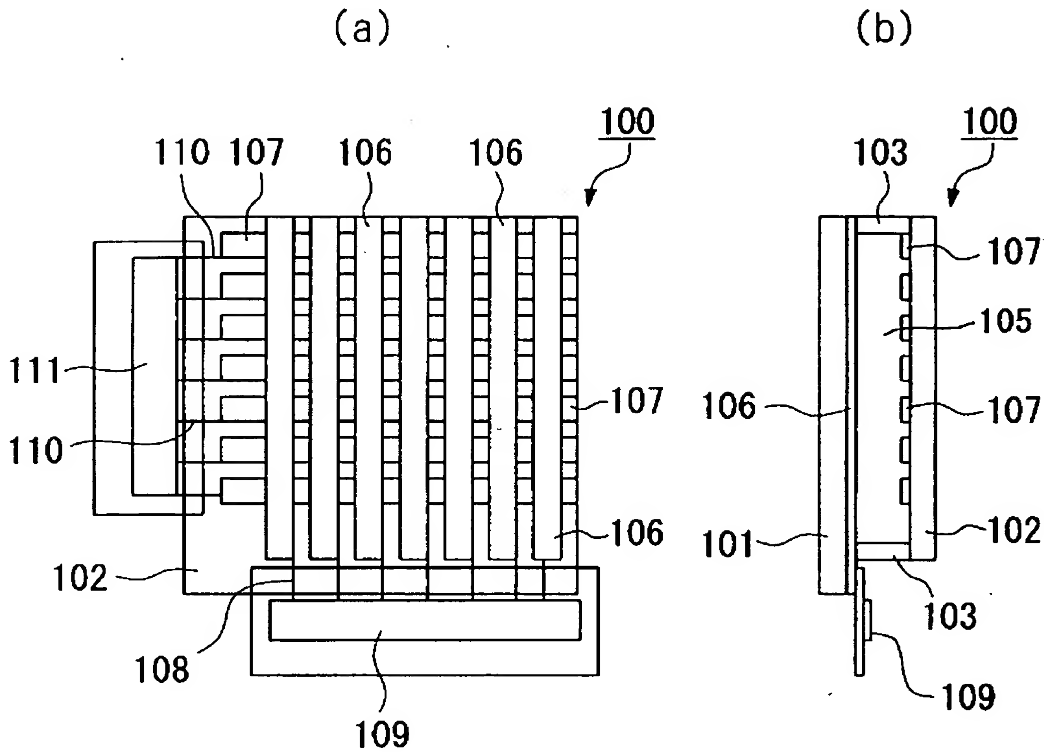


FIG.10


(a)
(b)
100
110
107
106
106
111
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109
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106
100
103
107
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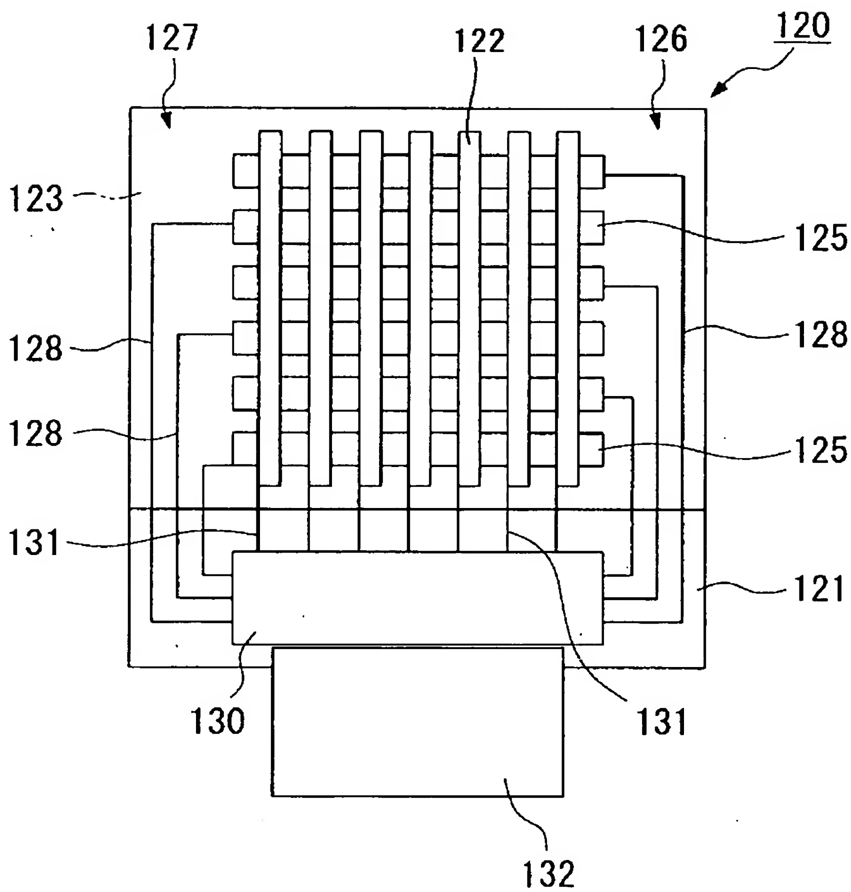
101
102
103
109

FIG.11



[Designation of Document] Abstract

[Abstract]

[Problem] To provide an electro-optical device that can lower resistance for routing wirings provided in a picture-frame area around an image display region and that can perform display with uniform brightness in an electrode means located closer to a drive circuit means or in an electrode means located farther from a drive circuit means.

[Means for Resolution] In the present invention, the routing wirings 20, 21 to connect a drive circuit means 6 to an electrode are formed on one of the substrates that corresponds to a picture-frame area located at both the end sides of the electrodes extending in one of the directions along which a plurality of electrodes 13, 18 are arranged in a matrix shape, routing sub-wirings 16, 17 are formed in a picture-frame area on the other substrate not formed with the routing wirings so as to face the routing wirings, and the routing wirings and the routing sub-wirings facing each other on both the substrates are conducted by vertical conduction members laid between the substrates.

[Selected Drawing] FIG. 1